causes in itself would produce such results, but combined they do bring on these so-called "cloud-bursts." From my observation on these islands, as well as in the States, I am inclined to think that meteorologists altogether undervalue the latter cause.

Snow fell on Mauna Kea, Mauna Loa, and Haleakala during these storms.

An earthquake was reported at Hilo March 30, 10:9 p. m. Heavy surf 1st to 7th; 15th to 24th.

Mr. Fleming, at the Magnetic Observatory, reports the mean dew-point, 62.6°; relative humidity, 73.4. Dr. Bond, Kohala, reports mean dew-point, 64.1°; mean relative humidity, 86.

OBSERVATIONS AT HONOLULU.

The station is at 21° 18′ N., 157° 50′ W.

Hawaiian standard time is 10h 30m slow of Greenwich time. Honolulu local mean time is 10h 31m slow of Greenwich.

Pressure is corrected for temperature and reduced to sea level, and the gravity correction, —0.06, has been applied.

The average direction and force of the wind and the average cloudiness for the whole day are given unless they have varied more than usual, in which case the extremes are given. The scale of wind force is 0 to 12, or Beaufort scale. Two directions of wind, or values of wind force, or amounts of cloudiness, connected by a dash, indicate change from one to the other.

The rainfall for twenty-four hours is measured at 9 a. m. local, or 7.31 p. m., Greenwich time, on the respective dates.

The rain gage, 8 inches in diameter, is 1 foot above ground. Thermometer, 9 feet above ground. Ground is 43 feet, and the barometer 50 feet above sea level.

*Meteorological Observations at Honolulu, March, 1902.*

| Date. | Pressure at sea level. | Temperature. | | During twenty-four hours preceding 1 p. m. Greenwich time, or 1:30 a. m. Honolulu time. | | | | | | | Sea-level pressures. | | Total rainfall at 9 a. m., local time. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Temperature. | | Means. | | Wind. | | Average cloudiness. | | | |
| | | Dry bulb. | Wet bulb. | Maximum. | Minimum. | Dew-point. | Relative humidity. | Prevailing direction. | Force. | | Maximum. | Minimum. | |
| | * | † | † | | | ‡ | ‡ | | § | | | | |
| 1 | 30.05 | 67 | 58.5 | 72 | 63 | 54.0 | 65 | nne–sw. | 6–2 | 4 | 30.09 | 29.99 | 0.01 |
| 2 | 30.06 | 68 | 60 | 73 | 65 | 54.5 | 60 | ne. | 6–7 | 5 | 30.12 | 30.03 | 0.04 |
| 3 | 30.06 | 68 | 62 | 74 | 66 | 56.7 | 64 | ne. | 5–6 | 4 | 30.14 | 30.05 | 0.24 |
| 4 | 30.02 | 70 | 63 | 74 | 65 | 58.5 | 67 | ne. | 6–7 | 6–10 | 30.10 | 29.98 | 0.80 |
| 5 | 29.99 | 69 | 61 | 71 | 65 | 59.3 | 72 | ne. | 5–7 | 10 | 30.10 | 29.98 | 1.60 |
| 6 | 29.97 | 68 | 66 | 73 | 66 | 59.3 | 72 | ne. | 5–7 | 8 | 30.02 | 29.93 | 0.90 |
| 7 | 30.05 | 68 | 64 | 73 | 67 | 64.3 | 86 | ne. | 4 | 9 | 30.07 | 29.96 | 0.70 |
| 8 | 30.04 | 68 | 62.5 | 72 | 67 | 61.3 | 75 | ne. | 4–5 | 4 | 30.09 | 30.01 | 0.02 |
| 9 | 30.01 | 63 | 62 | 74 | 67 | 60.3 | 72 | ne. | 4–0 | 6–10 | 30.07 | 30.00 | 0.02 |
| 10 | 30.01 | 63 | 62 | 78 | 62 | 62.5 | 77 | ne. | 0–4 | 3 | 30.05 | 29.96 | 0.00 |
| 11 | 30.00 | 63 | 62.3 | 79 | 62 | 63.5 | 81 | ne–se. | 0–2 | 3–0 | 30.06 | 29.95 | 0.00 |
| 12 | 30.00 | 65 | 63.7 | 78 | 63 | 64.7 | 85 | se. | 1–0 | 1–4 | 30.02 | 29.94 | 0.00 |
| 13 | 30.02 | 62 | 61.3 | 80 | 63 | 63.7 | 80 | se–ne. | 1 | 3–0 | 30.07 | 29.96 | 0.00 |
| 14 | 30.04 | 65 | 63 | 79 | 61 | 63.5 | 78 | ne. | 2 | 2 | 30.07 | 29.98 | 0.00 |
| 15 | 30.00 | 71 | 67 | 79 | 63 | 64.7 | 77 | ne. | 3–0 | 1 | 30.08 | 29.97 | 0.00 |
| 16 | 29.98 | 71 | 64 | 79 | 70 | 63.3 | 72 | ne. | 3 | 4 | 30.07 | 29.95 | 0.00 |
| 17 | 29.96 | 67 | 64 | 78 | 70 | 61.5 | 72 | ne. | 3 | 6–1 | 30.06 | 29.96 | 0.13 |
| 18 | 29.94 | 67 | 64.5 | 76 | 63 | 61.5 | 72 | ne–e. | 5–1 | 7–1 | 29.99 | 29.92 | 0.23 |
| 19 | 29.89 | 65 | 63 | 73 | 64 | 63.0 | 78 | ne. | 3 | 8–3 | 29.99 | 29.90 | 0.01 |
| 20 | 29.95 | 66 | 63.5 | 79 | 65 | 62.3 | 75 | ne. | 3–4 | 2 | 29.99 | 29.89 | 0.02 |
| 21 | 29.95 | 70 | 67.5 | 79 | 65 | 63.3 | 75 | se–ne. | 2 | 4 | 30.02 | 29.90 | 0.06 |
| 22 | 29.97 | 69 | 66 | 75 | 70 | 64.7 | 78 | ne. | 3–4 | 8 | 30.06 | 29.98 | 0.80 |
| 23 | 29.96 | 71 | 64 | 75 | 68 | 63.7 | 76 | ne. | 3–5 | 9 | 30.04 | 29.95 | 0.03 |
| 24 | 29.99 | 71 | 66.5 | 74 | 71 | 62.7 | 75 | ne. | 4 | 9 | 30.06 | 29.97 | 0.34 |
| 25 | 29.91 | 71 | 68.5 | 74 | 69 | 64.7 | 78 | ne. | 4–5 | 10 | 30.02 | 29.91 | 0.66 |
| 26 | 29.87 | 68 | 67 | 77 | 71 | 68.5 | 89 | ne–se. | 1–0 | 8–10 | 29.95 | 29.86 | 0.80 |
| 27 | 29.86 | 69 | 68.3 | 79 | 66 | 70.0 | 89 | s. | 1–2 | 4–10 | 29.93 | 29.85 | 0.48 |
| 28 | 29.90 | 70 | 69 | 73 | 68 | 68.5 | 95 | se. | 1 | 10 | 29.96 | 29.86 | 1.64 |
| 29 | 29.89 | 70 | 69.3 | 76 | 66 | 69.0 | 91 | sw. | 1–0 | 10 | 29.95 | 29.85 | 0.28 |
| 30 | 29.82 | 69 | 67.5 | 77 | 69 | 69.0 | 88 | sw–ne. | 1–0 | 10 | 29.95 | 29.82 | 0.06 |
| 31 | 29.79 | 64.7 | 64.3 | 77 | 67 | 66.5 | 88 | s–n. | 1–2 | 10 | 29.85 | 29.76 | 1.80 |
| Sums | | | | | | | | | | | | | |
| Means. | 29.966 | 67.6 | 64.2 | 75.9 | 66.5 | 63.4 | 78.2 | | | 3.0 | 6.0 | 30.038 | 29.935 | 11.67 |
| Departure. | —.041 | | | | | +2.0 | +5.0 | | | | +1.4 | | | +7.96 |

Mean temperature for March, 1902, (6 + 2 + 9) ÷ 3 = 70.8; normal is 70.8. Mean pressure for March, 1902, (9 + 3) ÷ 2 = 29.976; normal is 30.017.

*This pressure is as recorded at 1 p. m., Greenwich time. †These temperatures are observed at 6 a. m., local, or 4.31 p. m., Greenwich time. ‡These values are the means of (6 + 9 + 2 + 9) ÷ 4. §Beaufort scale.

## CLIMATOLOGY OF COSTA RICA.

Communicated by H. PITTIER, Director, Physical Geographic Institute.

[For tables see page 156.]

*Notes on the weather.*—On the Pacific side the weather was fair and fine, excepting a few days with occasional showers at the beginning and toward the end of the month. In San Jose the air pressure was generally above normal up to the 15th and below normal after that date. The temperature was about normal, while the dryness of the atmosphere was remarkable. Although there were four days of rainfall (against two, mean number for thirteen years), the sunshine was nearly fifty hours in excess of the normal. On the Atlantic side there was little rain, and the weather was generally fine.

*Notes on earthquakes.*—March 18, 5h 44m p. m., slight shock, NW-SE, intensity III, duration 7 seconds.

## FURTHER EXPLANATIONS.

By SIMON NEWCOMB, dated January 20, 1902.

Not until a few days ago was I aware that a paper asking certain critical questions about statements on meteorological subjects made by me in a popular article, had appeared in the MONTHLY WEATHER REVIEW for August, 1901. I shall take up the three points in question, seriatum.

The first concerns the cause of rain. I think it quite likely that I may be wrong in this point, and, therefore, shall not argue it, but merely remark that I have not yet seen any explanation of an all-day rain which seemed to me any more satisfactory than the old one which I mentioned.

The second point at issue is the cause of a thunderstorm. I attributed this to a rise of warm air and a fall of cold air to take its place. On this the Editor remarks: "The development of electricity by the rise of hot air and the descent of cold air is, we believe, a new thought in the physics of the atmosphere."

This remark seems to show that theoretical meteorology is either much less advanced or much more advanced than I had supposed. The above view was based purely on those casual observations which everyone may make in the course of his life. When, however, they are challenged, one hardly knows where to begin. I shall, therefore, confine myself to a statement of propositions, asking the Editor to point out where his dissent comes in:

(1) In spring and early summer it frequently happens that the excess of temperature of the air near the ground above that at a higher elevation is greater than the excess in a state of adiabatic equilibrium.

(2) The necessary result of this state of things is an instability of equilibrium. The colder air above at some point breaks through the stratum of warm air below and the latter rises up to take its place.

(3) The result is a colder wind blowing away from the place where the descent occurs and toward the place where the air is ascending. We thus have the familiar phenomenon at the commencement of a thundershower, when for a few minutes a heavy wind blows away from the seat of the storm.

(4) This state of things is nearly always accompanied by lightning, and the other phenomena of a thunderstorm.

(5) Lightning is produced by an electric disturbance and involves a generation of electric potential. Why or how the motion of the air should generate this potential, I must leave to others.

All I am stating are what appear to me the observed facts. If my propositions are wrong, I should like to have them corrected by a clear statement of the facts and causes of a thunderstorm.

The third point surprises me yet more, unless the Editor misapprehends my meaning when I speak of winds blowing in opposite directions. By this expression I meant merely opposite directions relative to the center of the advancing storm, or the center of disturbance. Different directions, would have been sufficient to say.

The Editor remarks: "The formation of a cyclone or whirlwind, as a consequence of winds blowing in opposite directions, is another theory long since abandoned. His omission of my phrase "near the place where the volume rises," I leave him to explain.